NON-PUBLIC?: N
ACCESSION #: 9411080242

LICENSEE EVENT REPORT (LER)

FACILITY NAME: HOPE CREEK GENERATING STATION PAGE: 1 OF 6

DOCKET NUMBER: 05000354

TITLE: Reactor Protection System Actuation - Main Turbine Trip
due to component failure in Electro Hydraulic Control
System.
EVENT DATE: 10/07/94 LER #: 94-015-00 REPORT DATE: 11/04/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 016

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: Lou Aversa, Senior Staff Engineer - TELEPHONE: (609) 339-3386
Technical

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS: no

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On Friday, October 7, 1994, with a reactor startup in progress, operators were preparing to roll the main turbine generator. The reactor was operating at approximately 15% of rated with 6 turbine bypass valves open. The Nuclear Control Operator (NCO - RO licensed) had selected the 100 RPM speed demand at the Electro Hydraulic Control System (EHC) panel which should have brought the turbine to the selected speed. The NCO monitoring the turbine roll initially observed normal responses from the Turbine Stop Valves (TSV's) position indicators, the "all valves closed" light extinguishing and the "speed increasing" light illuminating. The operator then observed that all turbine bypass valves had closed. This unexpected response was immediately recognized and communicated to other control room personnel by both the NCO and Shift Technical Advisor (STA -

SRO licensed). Control room personnel concurrently noted turbine speed had exceeded the 100 RPM selected speed and was accelerating rapidly. The Nuclear Shift Supervisor (NSS - SRO licensed) directed the NCO to trip the main turbine. The NCO recommended to shut down the turbine by selecting "all valves closed". When the turbine "all valves closed" was selected and the valves began to close, a reactor scram occurred. The root cause of this event was attributed to failed components in the EHC control circuit. A contributing factor was operators not recognizing the abnormal plant conditions indicated on the EHC panel when the turbine was reset prior to initiating the turbine roll. Corrective actions included replacement of the EHC card, revising the turbine roll procedures and expanding operator training to include actions to be taken when abnormal plant responses are noted.

END OF ABSTRACT

PLANT AND SYSTEM IDENTIFICATION

General Electric - Boiling Water Reactor (BWR/4)
Main Turbine Generator (CA) EIIS IDENTIFIER (TA)
Main Turbine Generator Control System (CH) EIIS IDENTIFIER (TG)

IDENTIFICATION OF OCCURRENCE

TITLE (4): Reactor Protection System Actuation - Invalid Main Turbine Trip results in Reactor Scram due to component failure.

Event Dates: 10/7/94
Event Time: 0730
This LER was initiated by Incident Report No. 94-169

CONDITIONS PRIOR TO OCCURRENCE

Plant in OPERATIONAL CONDITION 1 (Power Operation)
Reactor Power 15% of rated, 0 MWe

DESCRIPTION OF OCCURRENCE

On Friday, October 7, 1994, with a reactor startup in progress, operators were preparing to roll the main turbine generator. The reactor was operating at approximately 15% of rated with 6 turbine bypass valves open. The Nuclear Control Operator (NCO - RO licensed) had selected the 100 RPM speed demand at the Electro Hydraulic Control System (EHC) panel which should have brought the turbine to the selected speed. The NCO

monitoring the turbine roll initially observed normal responses from the Turbine Stop Valves (TSV's) position indicators, the "all valves closed" light extinguishing and the "speed increasing" light illuminating. The operator then observed that as the turbine speed began increasing all turbine bypass valves had closed. This unexpected response was immediately recognized and communicated to other control room personnel by both the NCO and Shift Technical Advisor (STA -SRO licensed). Control room personnel concurrently noted turbine speed had exceeded the 100 RPM selected speed and was accelerating rapidly. The Nuclear Shift Supervisor (NSS - SRO licensed) directed the NCO to trip the main turbine. The NCO recommended to shut down the turbine by selecting "all valves closed". When the turbine "all valves closed" was selected and the valves began to close, a reactor scram occurred. The NCO immediately inserted a manual scram and turbine trip.

ANALYSIS OF OCCURRENCE

The main turbine EHC system is designed to control the opening of turbine control valves (TCV's) based on turbine speed control circuits during startup and pressure control circuits when the turbine/generator is synchronized to the power grid. The turbine trip inputs to the Reactor Protection System are active when the reactor is operating above 30% power. This power level is determined by turbine first stage steam pressure. If the turbine stop or control valves close with first stage pressure above the setpoint, a reactor scram will occur. Below the setpoint sufficient bypass valve capacity exists to prevent a reactor pressure transient; hence the scram is bypassed.

Normal turbine control valve position during chest warming is closed. Upon exiting chest warming, the TCV's should remain closed as the speed control circuits in the EHC logic provide a zero percent open command to the valves through a low value gate. Subsequent investigation determined that, upon exiting chest warming, Control Room Integrated Display System (CRIDS) points that indicate the TCV's are not fully closed went into alarm. The TCV's were cracked open, just off the fully closed position, which was not readily apparent on the EHC panel TCV position indicators. The TCV's were attempting to open due to an invalid open signal being generated by the speed control circuits. The TCV's were not opening due to a closed demand signal into this same low value gate from the Load Limit Control circuit which is calling for zero percent valve opening. This was evident due to the Load Limit Control light on the turbine control panel being illuminated.

After the operator selected "100 RPM", the Load Limit circuit open demand

automatically increased and was no longer the limiting signal into the low value gate. The speed circuit which should have been the lowest signal into the low value gate was now the highest. The lowest value into the gate now became the pressure control signal which was providing an open demand based on steam line pressure. The first unexpected response noticed was the six bypass valves closing. The control cir
uits
are designed with a small closing bias signal to the bypass valves to prevent both the TCV's and bypass valves from opening simultaneously. The desired flowpath is for steam to flow to the turbine with the bypass valves only opening when demand to the turbine control valves is less than the total flow demand from pressure control circuit.

Due to the malfunctions in the speed control circuit, the turbine speed increased rapidly beyond the selected setpoint. The TCV's are normally opened slowly in coordination with the Combined Intermediate Valves (CIV's) which admit steam to the low pressure turbines. The CIV's opening is controlled by independent circuits in the EHC logic which are not affected by the pressure control circuit or the failed card. The CIV's open in approximately two minutes; hence, steam which entered the high pressure turbine prior to the CIV opening, effectively had no exhaust path.

ANALYSIS OF OCCURRENCE (Con't)

This resulted in the high pressure turbine pressurizing and activating the turbine trip input to the reactor protection system. When the operator selected all valves closed and the TSV's closed, both signals needed for the scram were satisfied. This resulted in the reactor scram.

Subsequent to the scram, the plant response was as expected. Reactor pressure quickly decreased following the scram. This condition could be expected since the plant was recovering from a scram the previous Sunday, which resulted in minimal decay heat.

Troubleshooting after the scram, included an extensive set of measurements taken at various points in the EHC system and documented in order to facilitate the diagnosis of any speed control problem. The speed error filter (SEF) card was found to have a -5.1 vdc output with a +5.8 vdc input. The output and input should have been the same. The -5.1 vdc SEF output corresponded to a full open signal for the control valves. All other readings were normal. In order to ascertain the input-output relation at the failed condition, a variable dc voltage (within the designed range) was applied to the SEF input. In all cases,

the output would initially change but would stabilize at -5 vdc.

The card was then removed for inspection. The +/- 15 vdc power supply filter capacitors were found to have been damaged. The +15 vdc leg capacitor (C1) was deformed and brownish in color while the -15 vdc leg capacitor (C2) was totally destroyed. Although failed capacitors were found, it was determined that a failed open capacitor would not cause the output of the card to respond as earlier testing indicated. The voltage on TP-4 of the control valve servo-amplifier card, A48, was tested with SEF removed to see if any other path or circuit may have existed. TP-4 receives the SEF output through a potentiometer. The voltage was 0.0 vdc confirming no additional path or circuit existed.

When it was determined that the only identified failure on the card could not account for the speed circuit malfunction, it was decided to re-insert the card into the circuit and continue troubleshooting. When the card was reinstalled, the output of the card did respond correctly, as expected, to the particular dc inputs.

The card was then taken to the Instrument and Controls shop and a test was performed by shorting the C1 capacitor, and applying 3 vdc to the input. It showed that with the C1 capacitor shorted, the output of the card responded as earlier testing indicated. As shorting the capacitor is the only failure that could account for the earlier indications it was postulated that the capacitors may have shorted initially to induce the malfunction and the short may have failed open when the card was removed from the rack. This would explain why the SEF card output failed at -5.1 vdc.

ANALYSIS OF OCCURRENCE (Con't)

Based on the above findings, the credible primary root cause of the control valves opening out of sequence was the malfunctioning of the SEF card due to a shorted capacitor. The CRIDS chronology documents the particular effects of the SEF card failure prior to and after the turbine rollup. A review of the earlier CRIDS chronology revealed that the failure existed prior to this startup.

A new SEF card was bench calibrated and installed. The control system was tested and determined to be in proper operating state. The SEF card was added to the EHC logic via a design change in 1988. The card was intended to attenuate unwanted control valve movement, hydraulic actuator and tubing vibration. These vibrations were caused by noise induced in the speed controller by the turbine toothed wheel used for speed

indications. The Safety Evaluation of the DCP addressed that although the change would improve overall system reliability by reducing duty on the turbine control valve hydraulic components, adding electronic components to the system may slightly decrease the speed control reliability. The vendor, at that time, was not aware of any failures on about 50 operating systems with the SEF in service.

In order to determine if any damage had occurred to the turbine, due to the rapid acceleration, chronology of the event was presented to General Electric for evaluation. GE indicated that there was no such possibility.

To ensure no other possible failure modes existed the following actions were taken. The SEF backplane connector was checked to see whether any improper or loose connection could cause the SEF output to go -5 vdc irrespective of the inputs (within range). There was no finding to that effect. A review of the maintenance activities previously performed was also reviewed. No maintenance activities or operations were identified as credible sources that could induce such a failure of the SEF card. Both the power supply and voltage regulator, which power the card, were tested to verify that no transient voltage conditions existed that could have affected the capacitors. Likewise, eight additional cards, in the EHC panel, that have similar capacitors were tested with satisfactory results.

The failed SEF card was taken to a Westinghouse Lab for further testing. No other components besides the two capacitors were found to be damaged.

Operator response to evaluate the initial abnormal indications was appropriate. The operators response to the turbine speed increasing above the selected setpoint should have been to trip the turbine. At the time of the event, procedural guidance and expectations were not adequate.

SAFETY SIGNIFICANCE

This incident posed minimal safety significance. Plant systems designed to mitigate this type of event operated per design.

PREVIOUS OCCURRENCES

There has been one previous reportable event of a turbine trip and reactor scram due to a failure of a component in the EHC control system. See LER 93-004-00.

APPARENT CAUSE OF OCCURRENCE

The root cause of this event was attributed to failed components in the EHC control circuit. Contributing factors were operators not recognizing the abnormal plant conditions, indicated on the EHC panel, when the turbine was reset prior to initiating the turbine roll, and less than adequate guidance existed regarding operator action to mitigate this type of event.

CORRECTIVE ACTIONS

The EHC card has been replaced and tested satisfactorily.

Failure analysis has been performed on the failed card and is being evaluated for appropriate corrective action(s).

Operator training will be expanded to include normal response vs. abnormal response and what actions to take if an abnormal response is observed for major or key evolutions.

The turbine startup procedure was revised to provide additional pre-roll checks of control status. The revision also included direction on valve sequence and speed monitoring during roll evolutions.

An additional revision is being made to the above procedure adding immediate operator actions that are to be taken if the selected turbine speed is exceeded.

Sincerely,

R.J. Hovey
General Manager -
Hope Creek Operations

SORC Mtg. 94-77 Recommended approval: Yes
C Distribution

ATTACHMENT TO 9411080242
PAGE 1 OF 1
PSEG

Public Service Electric and Gas Company P. O. Box 236 Hancocks Bridge, New Jersey 08038

Hope Creek Generating Station

November 4, 1994

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Dear Sir:

HOPE CREEK GENERATING STATION
DOCKET NO. 50-354
UNIT NO. 1
LICENSEE EVENT REPORT 94-015-00

This Licensee Event Report is being submitted pursuant to the requirements of 10CFR 50.73(a)(iv).

Sincerely,

R.J. Hovey
General Manager -
Hope Creek Operations

LAA/

Attachment
SORC Mtg. 94-077
C Distribution

The Energy People 95-273 (25M) 12-89

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